



PATENT APPLICATION  
STC-03-0009

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re application of: Gopalakrishnan Juttu  
Robert Scott Smith

Serial No.: 10/792,319

Group Art Unit: 1764

Filed: December 30, 2005

Examiner: Thuan D. Dang

For: CATALYST FOR AROMATIZATION OF ALKANES, PROCESS OF MAKING AND  
PROCESS OF USING THEREOF

Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

AFFIDAVIT UNDER 37 CFR §1.132

Scott F. Mitchell, being duly sworn, deposes and says that:

I am a scientist for SABIC Americas, Inc., at the SABIC Technology Center in Sugar  
Land, Texas.

My educational background is as follows: I hold a Bachelor of Science degree in  
Chemical Engineering from the University of Pennsylvania granted in 1983, a Master of Science  
degree in Chemical Engineering from the University of Pittsburgh granted in 1987 and a Doctor  
of Philosophy degree in Chemical Engineering from the University of Pittsburgh granted in  
1987.

My duties at the SABIC Technology Center include research in the field of catalytic  
reaction of an alkane using a zeolite catalyst to produce aromatics, including the synthesis and  
evaluation of catalysts such as those disclosed in the U.S. patent no 4,766,265 to Desmond et al  
("Desmond").

I have worked in the field of catalysis, both in industry and in academia, for approximately twenty years. I am the author or co-author of approximately seven articles on the subject and have approximately five patents issued or patent applications pending naming me as an inventor or co-inventor in this field. I am an invited reviewer for the National Science Foundation, the Journal of Catalysis, the AIChE Journal and Applied Catalysis.

In view of my qualifications as specified above, I consider myself to be an expert in the art of alkane aromatization and related catalysts, specifically the catalytic reaction of an alkane using a zeolite catalyst to produce aromatics. I have read the Office Action of March 9, 2005, for the above identified patent application and I have reviewed and am familiar with the subject matter disclosed in U.S. Patent no. 4,766,265 to Desmond et al ("Desmond").

The following Example and Comparative Examples illustrate a catalyst of the claimed invention compared to those of the cited Desmond patent.

**Example 1: Pt/Ga/ZSM-5**

25.08g of CBV5524 (ZSM-5 with  $\text{SiO}_2/\text{Al}_2\text{O}_3 \sim 55$ ; Zeolyst Inc.) were combined with 6.43g of Ultrasil VN3SP (amorphous precipitated silica; Degussa) in a ceramic crucible. 40g of Ludox TM-50 (50wt% colloidal silica; Aldrich) was added to the above mixture and mixed well. Deionized (DI) water was added to the mixture which was worked into homogeneous dough. The dough was dried at 90°C for 4 hours and then calcined in a muffle furnace with air flow at 550°C for 6 hours.

The calcined material was crushed and sieved to 20/40 mesh. The sized material was ion exchanged with 0.5M  $\text{NH}_4\text{NO}_3$  solution at 60°C. The solution was decanted and the solid material was washed with DI water. The ion exchange was repeated two more times. The ion

exchanged material was dried at 90°C for 4 hours and then calcined in a muffle furnace with air flow at 550°C for 6 hours.

3.5g of gallium nitrate hydrate (Aldrich) was dissolved in 25ml DI water. 26.53g of the catalyst from above was impregnated with this gallium solution. The impregnated catalyst was dried at 90°C for 4 hours and then calcined in a muffle furnace with air flow at 550°C for 6 hours.

0.083g of tetraamine platinum (II) nitrate (Alfa-Aesar) was dissolved in 22ml of DI water. 22.32g of the catalyst from the step above was impregnated with the platinum solution. The impregnated catalyst was dried at 90°C for 4 hours and then calcined in a muffle furnace with air flow at 300°C for 6 hours.

A Comparative Example for a catalyst containing platinum and rhenium metals deposited on gallium-ZSM-5 was prepared as follows:

**Comparative Example 1: Re/Pt/Ga/ZSM-5**

0.098g of ammonium perrhenate (Strem Chemicals) was dissolved in 10ml of DI water. 10.77g of Pt/Ga/ZSM-5 from above was impregnated with the rhenium solution. The impregnated catalyst was dried at 90°C for 4 hours and then calcined in a muffle furnace with air flow at 300°C for 6 hours.

For each of the catalysts from the Example and Comparative Example above, unless specified otherwise, 4g of the sized catalyst (20-40 mesh) was loaded into the reactor and reduced at 400°C under 50-50 H<sub>2</sub>/N<sub>2</sub> stream (total flow rate = 60ml/min) for 4 hours. The catalyst

was then sulfided with 1vol% H<sub>2</sub>S (remainder N<sub>2</sub>) until there was a breakthrough of H<sub>2</sub>S

(typically 1.5 hours). The catalyst was then swept with 50-50 H<sub>2</sub>/N<sub>2</sub> stream for 1 hour. Propane was then introduced into the reactor at 34 ml/min with the reactor ramped to the desired reaction temperature (typically 500°C). The reactor was held at 22 psig pressure during the reaction.

The results are summarized in the Table below

Table 1

	Conversion	BTX Selectivity	Yield
Example 1	52%	41%	21.3%
Comparative Example 1	48%	42%	20.2%

For each of the catalysts from the Example and Comparative Example above, 4g of the sized catalyst (20-40 mesh) was loaded into the reactor and tested as above but without the sulfide pretreatment.

The results are summarized in the Table below

Table 2

	Conversion	BTX Selectivity	Yield
Example 1	62%	40%	24.8%
Comparative Example 1	63%	38%	23.9%


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As can be seen from these results, a zeolite catalyst having gallium and silicon in the framework as described by Desmond on which a metal consisting essentially of platinum has been deposited has better performance in a process for the aromatization of alkanes than that for a zeolite catalyst having gallium and silicon in the framework as described by Desmond on which platinum and rhenium has been deposited, specifically a better yield for BTX aromatics.

Further deponent saith not.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affix my signature this  
11 day of July, 2005.

  
\_\_\_\_\_  
Scott F. Mitchell

On this 11<sup>th</sup> day of July, 2005, personally appeared before me,  
Scott F. Mitchell, known to me to be the person who executed the foregoing affidavit and  
acknowledged the same to be her free act and deed.

  
\_\_\_\_\_  
Notary  
My Commission expires June 7, 2009

